BIRLA INSTITUE OF TECHNOLOGY AND SCIENCE, PILANI

SECOND SEMESTER 2017-2018

EEE F431 MOBILE TELECOMMUNICATION NETWORKS

Comprehensive Examination (Part A: Closed Book)

Make-Up (July 28, 2018)

MAX. DURATION: 120 min **Max. Marks: 60**

Note: All questions carry equal marks. Write your answer precisely to-the-point for each theoretical question. Assume and state typical but valid values, if not given, while solving a numerical.

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1. Consider an indoor wireless LAN with f_c = 900 MHz, cells of radius 1.0 km, and non-directional antennas. Under the free-space path loss model, what transmit power is required at the access point in order for all terminals within the cell to receive a minimum power of 10nW? How does this change if the system frequency is 2.40 GHz?

2. List issues as cellular systems migrate to smaller cells in order to increase system capacity.

3. Assume that a GSM, IS-95 and U.S. digital cellular base station transmit the same power over the same distance. Which system will provide the best SNR at a mobile receiver? What is the SNR improvement over the other two systems? Assume a perfect receiver with only thermal noise present in each of the three systems.

4. What are the services provided by the IEEE 802.11 MAC?

5. A company owns two office towers in a city and wants to set-up a 5 GHz microwave link between them. Heights of two towers separated by 2000m are 75m and 30m. In the line of sight and midway between the towers is a third tower. Estimate height of third tower to allow a line of sight transmission between two towers.

6. What are the two categories of routing protocols for ad hoc networks?

7. Assume a narrowband digital system requires a C/I = 12 dB. What would be the maximum frequency reuse factor? If the addition of FEC coding would reduce this to 9 dB without increasing signal bandwidth, what would be the relative improvement in reuse factor? Assume that the propagation loss exponent is 2.5.

8. How is a connection between a host and Bluetooth device established?

9. Construct the waveform of the MSK signal for the binary sequence 1101000, assuming that the frequencies f_1 and f_2 are both odd integer multiples of $1/4T$.

10. How functions of DSSS systems differ from FHSS systems?

11. The multiple-access interference is a weighted sum of K-1 independent, identically distributed random variables. What is the mean and variance of the sum of K independent identically distributed binary random variables?

12. A mobile radio transmits data at 19.2 kbps in a 400-MHz band and must operate at vehicle speeds up to 100 km/hour. Design includes FEC through a 1/2 rate, constraint-length-7 convolutional code. Estimate expected duration of an error burst at top speed.

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SECOND SEMESTER 2017-2018
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Comprehensive Examination (Part B: Open Book)
Make-Up (July 28, 2018)

MAX. DURATION: 60 min **Max. Marks: 30**

Note: Assume and state typical but valid values, if not given. Do mention Figure/Equation number of textbook (TB) or reference book (RB#), if applied.

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1. Let a scattering function $S_c(\tau, \rho)$ be nonzero over $0 \leq \tau \leq 0.1$ ms and $-0.1 \leq \rho \leq 0.1$ Hz. Assume that the power of the scattering function is approximately uniform over the range where it is nonzero.
(a) What are the multipath spread and the Doppler spread of the channel?
(b) Suppose two identical sinusoids separated in time by Δt are fed to this channel. What is the minimum value of Δf for which the channel response to the first sinusoid is approximately independent of the channel response to the second sinusoid?
(c) For two sinusoidal inputs to the channel, $u_1(t) = \sin 2\pi ft$ and $u_2(t) = \sin 2\pi f(t + \Delta t)$, find the minimum value of Δt for which the channel response to $u_1(t)$ is approximately independent of the channel response to $u_2(t)$.
(d)Will this channel exhibit flat fading or frequency-selective fading for a typical voice channel with a 3-kHz bandwidth? for a cellular channel with a 30-kHz bandwidth?

2. Consider an asynchronous DSSS multiple access channel (MAC) system with bandwidth expansion, $N = B_s/B = 100$ and $K = 40$ users. Assume the system is interference limited and there is no multipath on any user's channel. Find the probability of error for user k under BPSK modulation, assuming random codes with the standard Gaussian assumption and assuming this user is in a deep fade, with received power that is 6 dB less than the other users. Would this change if the users could be synchronized?

3. Consider an OFDM system operating in a channel with coherence bandwidth $B_c = 10$ kHz.
(a) Find a subchannel symbol time $T_N = 1/B_N = 10T_m$, assuming $T_m = 1/B_c$. This should ensure flat fading on the subchannels.
(b) Assume the system has $N = 128$ subchannels. If raised cosine pulses with roll-off factor, $\beta = 1.5$ are used and if the required additional bandwidth (from time limiting) to ensure minimal power outside the signal bandwidth is $\varepsilon = 0.1$, then what is the total bandwidth of the system?
(c) Find the total required bandwidth of the system using overlapping carriers separated by $1/T_N$, and compare with your answer in part (b).
